



Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at <http://about.jstor.org/participate-jstor/individuals/early-journal-content>.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

BRIEFER ARTICLES.

THE PHYSIOLOGICAL CONSTANTS OF PLANTS COMMONLY USED IN AMERICAN BOTANICAL LABORATORIES. I.

THE series of papers of which this is the first will give the results of careful study undertaken to find which of our common plants are best adapted for the demonstration of each of the physiological phenomena of plant life. The work is being done in the Laboratory of Plant Physiology at Smith College with the advice of Professor W. F. GANONG. The literature of the various subjects is of course being used; but citation will be omitted for the most part, because the work is all being done *de novo*, and for the sake of teachers rather than investigators. It is intended that the resultant data shall enable teachers of botany to select in each case the best plant for the particular experiment in hand, and to know quantitatively the physiological behavior of each of the common kinds. Since most of the teaching of botany in this country is necessarily done in the winter, when out-of-door plants are not available, only greenhouse plants have been considered; and of these for the most part only the more common kinds, which can be grown in any ordinary room. Exceptions have been made in a few cases where a less common plant has been found to be especially good.

I. CHLOROPHYLL SPECTRA.

In order to compare the spectra of chlorophyll from different plants, it is necessary to adopt some standard solution and some uniform method of examining the leaves. The optimum amount of leaf for giving a clear solution, without filtering, from most leaves was found to be 25^{sq cm} of the leaf in 15^{cc} of 95 per cent. ethyl alcohol, and accordingly I have taken this as the standard solution. A larger proportion of leaf gives a clouded solution, which must either be filtered or be cleared by adding more alcohol. Solutions may be made equally well with methyl or wood alcohol.

The solutions were made as follows: A beaker was fitted with a cork in which three holes were made to allow two test tubes, holding the solutions, and a thermometer to be suspended in the beaker. The beaker was filled with water and set on a tripod over a Bunsen burner. The optimum temperature for extraction of the chlorophyll was found to be 50-55° C., at which the water in the beaker was kept. A tin hood was set over the

beaker to exclude all light during the extraction of the chlorophyll. In order to eliminate individual peculiarities, each experiment was done in duplicate for two different plants of each species studied. The time required for extraction of the chlorophyll from leaves of different species varied widely and is recorded for each case in the table following. Except where otherwise stated, half-grown leaves were used, as in most cases they yield the best solution in the shortest time.

It was found that the transparency of living leaves was increased if the air was driven from the intercellular spaces and its place was taken by water. Accordingly in these experiments the leaves were put in water under the air pump for half an hour and examined at once. If they are allowed to stand in water for an hour, leaves like *Pelargonium*, *Begonia*, *Oxalis*, etc., show the characteristic spectrum of incipient decomposition of chlorophyll. In the table the spectrum of a single leaf is given in each case.

The spectra were observed by a Kohl spectroscope, Hoffman form, with a comparison prism; one which is ample for all educational work. The Welsbach light was used.

As is well known, chlorophyll when examined by means of a spectroscope shows in all seven distinct absorption bands which are usually designated by the Roman numerals. I is a broad black band in the red; II is a narrow gray band in the red, near the orange; III is a gray band in the orange near the yellow; IV is a dark band in the middle of the green; V, VI, and VII are broad black bands in the blue, usually absorbing it to such a degree that with a few exceptions they can be seen separately only in a very thin layer of a dilute solution. These seven bands are never all present at one time.

In the following table the letter *d* means the band is dark; *f* that it is faint; *vf* that it is very faint; and *o* that it is absent. Where the spectrum of a living leaf differs from that of the chlorophyll solution its differences are indicated by the bracketed letters. The time required for the extraction of the chlorophyll is given in minutes. The thickness of the layer of the solution in each case was 15^{mm}. "Typical green" means the average unchanged color of chlorophyll.

In the table it will be seen that certain leaves are described as yielding a yellow-green solution. In all these cases the solution gives an acid reaction with litmus paper and the spectrum is of a distinct character from that of the other leaves. These facts, with others developed in the course of this study, show that we must distinguish between two distinct classes of chlorophyll spectra: the "normal chlorophyll spectrum" show-

Name of plant	Time in mins.	Color of solution	BANDS						
			I	II	III	IV	V	VI	VII
Abutilon (golden bells) (young leaf).....	5	typical green	d	d (o)	f	o	d	d	d
Asparagus Sprengeri.....	30	light green	d	vf	vf	o	d	d	d
Avena sativa (oats).....	5	bright green	d	d	f	o	d	d	d
Begonia coccinea.....	2	yellow	d	o	o	f	d	d	d
Begonia coccinea.....	15	brown-yellow	d	d (f)	o (f)	d (o)	d	d	d
Cineraria cruenta.....	10	bright green	d	o (f)	o (f)	o	d	d	d
Cestrum elegans (young leaf).....	5	dark green	d	f (vf)	f	o	d	d	d
Chrysanthemum frutescens.....	30	pale green	d	f (o)	o	o	d	d	d
Euphorbia pulcherrima (Poinsettia) (young leaf).....	10	dark green	d	f (o)	f	o	d	d	d
Ficus elastica (rubber plant).....	120	pale green	d	f	o	f	d	d	d
Ficus elastica (young leaf).....	15	pale green	d	d (o)	f (o)	f (o)	d	d	d
Ficus repens (young leaves).....	10	pale green	d	f (o)	f (o)	o	d	d	d
Fuchsia speciosa.....	15	yellow-green	d	o (f)	o (f)	f (o)	d	d	d
Hedera Helix (English ivy).....	5	dark green	d	d (o)	f (d)	vf (o)	d	d	d
Heliotropium peruvianum (Heliotrope).....	30	pale green	d	f (vf)	o (f)	o	d	d	d
Impatiens Sultanii.....	15	bright green	d	f (o)	o (vf)	o	d	d	d
Jacobinia magnifica (young leaf).....	30	dark green	d	f	f	o	d	d	d
Lycopersicum esculentum (tomato).....	10	pale green	d	vf	vf (f)	o	d	d	d
Oxalis Bowiei.....	15	yellow-green	d	f	o (f)	d (o)f (o)	o (d)	d	d
Pelargonium domesticum.....	15	yellow-green	d	f	o (f)	d (o)	d	d	d
Pelargonium peltatum.....	15	green-yellow	d	f (o)	o (o)	d (o)	d	d	d
Pelargonium zonale.....	15	brown-yellow	d	f	o (f)	d (o)	d	d	d
Primula obconica.....	1	bright green	d	f (o)	f (vf)	o	d	d	d
Primula sinensis (Chinese primrose).....	15	dark green	d	d (vf)	f	o	d	d	d
Primula verticillata.....	5	pale green	d	f (o)	f (vf)	o	d	d	d
Raphanus sativus (radish).....	2	bright green	d	d (o)	f (vf)	o	d	d	d
Ricinus communis (castor bean).....	15	pale green	d	f (vf)	f (vf)	o	d	d	d
Salvia involucrata.....	30	pale green	d	f (o)	f	o	d	d	d
Senecio mikanoides.....	15	pale green	d (f)	o	o	o	d (o)	d	d
Senecio Petasitis.....	15	typical green	d	f	f	o	d	d	d
Tropaeolum majus (nasturtium).....	30	typical green	d (f)	o	o	o	d (o)	d (c)	d
Vicia Faba (horse bean).....	2	bright green	d	f	f	o	d	d	d

ing bands I, II, III, V, VI, and VII, given by living leaves and by solutions made by extracting the chlorophyll quickly with only a minimum amount of heat; and the "decomposition chlorophyll spectrum," having bands I, II, IV, V, VI, and VII. This decomposition spectrum is given by solutions (a) from boiled leaves, (b) from leaves which contain acid salts (Oxalis, etc.), (c) by solutions made by prolonged immersion of leaves in cold alcohol, (d) by solutions in which the chlorophyll is decomposed by adding a drop of hydrochloric acid, or by exposure to direct sunlight for a few minutes, and (e) by living leaves after standing in water several hours.

On further decomposition of chlorophyll by light or acids an extra band appears in the green beyond IV and band V in the blue disappears. It is to be remembered that these spectra were given by standard solutions made as described above. With weaker solutions the bands become fainter, and with increasing diluteness bands II and III disappear.

Comparatively few living leaves show all the bands of the normal

chlorophyll spectrum in a single leaf, but all leaves give all these bands when two or three are used. The bands in the spectrum of a solution of chlorophyll were compared with those in the living leaf in two ways: (1) by observing the two spectra at the same time, one with direct light and the other by means of the comparison prism; (2) by observing the position of the bands in direct sunlight with reference to the Fraunhofer lines. In all cases the bands appear in exactly the same place in the spectrum of a leaf as in that of a standard solution giving the normal chlorophyll spectrum.

From the above it is plain that the most typical spectra are yielded by those non-acid leaves from which the chlorophyll can be extracted most easily, namely (in the order of their excellence) *Primula obconica*, *Raphanus sativus*, *Vicia Faba*, *Abutilon* (young leaf), *Avena sativa*, *Cestrum elegans* (young leaf), *Euphorbia pulcherrima* (young leaf), *Lycopersicum esculentum*, *Primula sinensis*, and *Ricinus communis*.

Another well-known optical property of chlorophyll is its fluorescence, all solutions of chlorophyll being slightly fluorescent. The products of the decomposition of chlorophyll, however, seem to be more fluorescent than chlorophyll itself. A solution of chlorophyll extracted with boiling alcohol from boiled leaves in the light is more fluorescent than a solution of unchanged chlorophyll. Of course some leaves are better than others, and of all the leaves in the above table, the very best are *Jacobinia magnifica*, *Cineraria cruenta* (the dark-leaved varieties), *Cestrum elegans*, and *Hedera Helix*. Standard solutions from these leaves give a brilliant blood-red fluorescence.—SOPHIA ECKERSON, *Smith College, Northampton, Mass.*

FURTHER OBSERVATIONS ON THE STRUCTURE OF THE STARCH GRAIN.¹

IN a previous paper (1) on the structure of the starch grain, I showed that the peripheral layer of the potato starch grain breaks and recurves on treatment with certain reagents, much like the cutin layer of an epidermal cell on treatment with sulfuric acid. While I had previously observed that this peripheral layer is stained with certain of the aniline dyes, I thought that the effect might probably be due to the remains of plastids or protoplasmic material, rather than to the presence of a distinct membrane. I am now satisfied, however, that it can be demonstrated that the peripheral layer of the starch grain is a distinct membrane.

It is well known that upon the addition of an iodine solution to unaltered

¹ Read at the meeting of the Society for Plant Morphology and Physiology, December 1903.